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**(54) Embossed Decorative Laminates**

(57) An embossed thermoset decorative laminate is prepared from an assembly comprising a noble resin impregnated decorative paper sheet of uniform thickness which is embossed by means of heat and pressure before

positioning in the assembly. The embossment being preserved during the consolidation process by means of a deformable press-pad adjacent to the embossed surface. By employing a decorative sheet bearing a printed pattern, registered embossed laminates may be prepared from conventional laminate components.

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## SPECIFICATION

## Improvements in or Relating to the Production of Decorative Laminates having Embossed Surfaces

- 5 The invention relates to the production of decorative thermoset plastic laminates having embossed surfaces and more especially to such laminates comprising a pre-embossed decorative paper sheet and methods for preparing such laminates.

Decorative thermoset plastics laminates have been known for many years and, conventionally, they comprise three layers:— a wear surface layer, a decorative layer beneath the wear surface layer and a rigidity imparting core layer supporting the superimposed decorative and surface layers.

- The wear surface layer commonly comprises a transparent noble thermoset resin impregnated high quality alpha-cellulose paper sheet, known as an overlay, or a coating comprising a noble thermoset resin and a finely divided filler such as barium sulphate, alumina, silica and/or finely divided cellulose, the noble thermoset resin being usually an aminotriazine-formaldehyde resin such as a melamine-formaldehyde resin.

- The decorative layer usually comprises a noble thermoset resin impregnated printed or plain coloured decorative paper sheet; the noble thermoset resin again being, commonly, an aminotriazine-formaldehyde resin such as a melamine-formaldehyde resin. When the decorative sheet is a plain coloured sheet it is possible to dispense with the wear surface layer as adequate required wear resistance may be obtained without it.

- When in the specification reference is made to noble resin, what is meant is thermosettable resins which show no appreciable change in colour or darkening on conversion from the thermosettable to the thermoset state. Such resins are known and include, for example, polyester resins, epoxy resins, aminotriazine resins, such as, melamine-formaldehyde, melamine-urea-formaldehyde, benzoguanamine-formaldehyde and acetoguanamine-formaldehyde resins and urea-formaldehyde resins.

- The rigidity imparting core layer usually comprises one or a plurality of superimposed thermoset phenol-formaldehyde resin impregnated kraft paper sheets, the number and thickness of the sheets being selected so that the finished laminate possesses the required thickness and rigidity.

- Such laminates are conventionally prepared by forming a stack of the component layers with the resins in the thermosettable form and then consolidating a plurality of like stacks to unitary thermoset structures by means of heat and pressure in an hydraulic press. Commonly the consolidation is performed using flexible release sheets whose purpose is to enable the consolidated laminate to be separated from the press-plates and the adjacent laminates, and, by

- 65 providing the release sheets employed with an appropriate surface finish, laminates with a complementary surface may be produced directly.

- It is known to prepare laminates having embossed surfaces by performing the consolidation by means of a press-plate having an embossed surface complementary to that desired to the product laminate and it is common to use an embossed press-plate to provide a decorative laminate having desired surface contours in conjunction with a release sheet which provides the desired surface texture.

- Embossed decorative laminates may be prepared from plane coloured decorative fibrous sheets, such a plain colour being obtained by the incorporation of suitably coloured dyes, fibres, threads or pigments during the manufacture of the sheet or by coating or printing the sheet after its preparation, or, from decorative sheets bearing a printed design.

- Registered embossed decorative laminates have an embossed surface and comprise a decorative sheet wherein the sheet is a fibrous sheet such as a paper, wood or fabric sheet and wherein the embossments are in register with a print pattern on the paper or fabric, the grain pattern of the wood sheet or the weave and/or coloured pattern of the fabric.

- There is a demand for laminates which exhibit embossed surfaces and which closely approach in appearance natural materials such as leather, slate, timber and fashioned materials such as woven materials, fabrics and tiles and these are conveniently prepared using appropriately printed decorative paper sheets.

- Generally the methods available for preparing a laminate which exhibits a decorative registered embossed surface are divisible into two groups depending upon whether the embossed surface is provided (a) by use of a contoured press-plate which does not become part of the product laminate (external embossing processes), or (b) by incorporating into the laminate assembly and the product laminate a sheet, such as a fabric, having a thickness variation which thickness variation provides the required registered embossment (internal embossing process).

- An example of the internal embossing process is that related in British Patent No. 1346800 wherein in place of, or in addition to, the decorative paper sheet, a decorative woven paper web or the like, having a thickness variation of 7 mils or more, is positioned in the stack and the consolidation is performed using a cushion layer which serves to maintain the thickness variation of the paper web and thus provide a decorative laminate having the embossment in register with the said web.

- Essential features of the said invention are that the paper web has the required thickness variation and remains uncrushed and a preferred feature is that the decorative paper web, or the like, has openings therethrough in order to provide adequate bonding to the underlying sheet. Accordingly, the manufacture of embossed

laminates according to the said invention requires the use of materials not conventionally employed in the production of decorative thermoset plastics laminates.

- 5 In accordance with the instant invention it is now apparent that decorative paper sheets of substantially uniform thickness used in the production of conventional laminates may be employed to provide a decorative laminate having an embossed surface of embossing the decorative sheet prior to its positioning in the stack of laminate components which is then consolidated to a unitary structure. More especially, those printed decorative paper sheets of substantially uniform thickness used in the production of conventional decorative laminates may be employed to provide registered embossed decorative laminates by embossing in register the printed decorative sheet prior to its positioning in the stack of laminate components which stack is then consolidated to a unitary structure.

- In order that the embossed decorative paper sheet substantially resists deformation when subjected to the consolidation pressure applied thereto when positioned in the stack from which the decorative laminate is prepared, it is necessary for it to be impregnated with a noble resin and the resin at least partially converted to the thermoset state before the consolidation process so as to impart the necessary resistance to deformation to the embossed decorative paper sheet.

- Hereinafter, when reference is made to 'a pre-embossed noble resin impregnated decorative paper sheet' what is meant is a decorative paper sheet of substantially uniform thickness which has been embossed and impregnated with a noble thermosettable resin and said resin at least partially thermoset prior to the sheet being positioned in a stack of laminate components. Whilst the decorative sheet may be embossed prior to impregnation with a thermosettable resin, the embossed sheet impregnated and the resin then converted, at least partially, to the thermoset state by heating under pressure, it is preferred either (a) to impregnate the decorative paper and then emboss the same whilst simultaneously converting the resin at least partially to the thermoset state, or (b) substantially simultaneously to emboss, impregnate and at least partially cure the resin to the thermoset state.

- According to a first aspect of the invention, a process for preparing an embossed thermoset decorative laminate comprises:—

- A: forming a stack comprising:—  
 (i) a core layer which comprises one or a plurality of thermosettable phenolic resin impregnated paper sheets;  
 60 (ii) a decorative layer which comprises a pre-embossed noble resin impregnated decorative paper sheet;  
 and, optionally:—  
 (iii) either a wear surface layer conforming in

- 65 contour to the pre-embossed noble resin impregnated decorative paper sheet and comprising a noble resin composition, which is at least partially thermoset;

- or a wear surface layer comprising an overlaying impregnated with a noble thermosettable resin composition;

B: forming an assembly comprising:—

- (i) said stack, and  
 (ii) a deformable thermoplastic or elastomeric press-pad adjacent said decorative sheet or wear surface layer, when present;

- C: applying heat and pressure to the assembly so as to cause the said press-pad to conform to said pre-embossed paper sheet and to consolidate the stack to form a unitary structure and to convert the thermosettable resins to the thermoset state;

- D: removing said deformable pad to provide an embossed thermoset decorative laminate, the contours of the decorative surface of which conform substantially to those of the pre-embossed noble resin impregnated decorative paper sheet.

- In accordance with the first aspect of the invention, there is provided a decorative embossed thermoset laminate comprising:—  
 (i) a core layer being one or a plurality of thermoset phenolic resin impregnated paper sheets;

- 95 (ii) a decorative layer being a pre-embossed noble resin impregnated decorative paper sheet, said resin being substantially fully cured to the thermoset state; and, optionally,

- (iii) a wear surface layer comprising a noble thermoset resin composition which layer conforms to the contours of said pre-embossed decorative paper sheet.

- According to a second aspect of the invention, there is provided a process for preparing a registered embossed thermoset decorative laminate comprising:—

A: forming a stack comprising:—

- (i) a core layer which comprises one or a plurality of thermosettable phenolic resin impregnated paper sheets;

- (ii) a decorative layer which comprises a pre-embossed noble resin impregnated decorative paper sheet bearing a printed pattern, wherein the embossments are in register with printed pattern;

115 and

- (iii) either a wear surface layer conforming in contour to the pre-embossed noble resin impregnated decorative paper sheet and comprising a noble resin composition which is at least partially thermoset;

- or a wear surface layer comprising an overlaying impregnated with a noble thermosettable resin composition;

B: forming an assembly comprising:—

- 125 (i) said stack, and  
 (ii) a deformable thermoplastic or elastomeric presspad adjacent said wear surface layer;

- C: applying heat and pressure to the assembly so as to cause the said press-pad to conform to said embossed paper sheet and to consolidate the stack to form a unitary structure and to convert the thermosettable resins to the thermoset state;
- 5 D: removing said deformable pad to provide a registered embossed decorative laminate the contours of the decorative surface of which
- 10 conform substantially to those of the pre-embossed noble resin impregnated decorative paper sheet.

- In accordance with the second aspect of the invention, there is provided a decorative
- 15 registered embossed thermoset laminate comprising:—
- (i) a core layer, being one or a plurality of, thermoset phenolic resin impregnated paper sheets;
- 20 (ii) a decorative layer being a pre-embossed noble resin impregnated decorative paper sheet bearing a printed pattern and wherein the embossments are in register with the printed pattern and the resin is substantially fully cured to
- 25 the thermoset state;
- (iii) a wear surface layer comprising a noble thermoset resin composition which layer conforms to the contours of said pre-embossed noble resin impregnated decorative paper sheet.
- 30 The phenolic resin impregnated paper sheets employed in the process of our invention are preferably those known for use in the production of conventional decorative laminates and/or chipboard panels, having a basis weight of from
- 35 about 80 to about 230 grams per square metre. More preferably they are prepared by impregnating a kraft paper web with a thermosettable phenol-formaldehyde resin composition, such as to provide, after drying to a
- 40 volatile content of from about 7% to about 10%, a resin content on the dried impregnated paper of from about 26% to about 32% by weight, and then cutting the web into sheets of the required size.
- 45 Optionally a barrier sheet, for example, an unbleached kraft paper sheet impregnated with a noble resin, may be positioned between the core and decorative layers to prevent bleed-through of the phenolic resin into the decorative layer.
- 50 The noble thermosettable resin composition employed to provide the decorative layer and the wear surface layer, when present, may be the same or different. However, it is preferred to employ the same resin to provide each layer and,
- 55 more especially, it is preferred that each layer comprises thermosettable melamine-formaldehyde resins and especially rapid curing melamine-formaldehyde resins.
- Rapid curing melamine resin compositions are
- 60 known such as, for example, those comprising acid or latent acid curing catalysts used in the production of melamine surface chipboard panels. It is preferred to employ those rapid-curing melamine resins so catalysed that, when

65 subjected to the embossing process, the pressure and heat applied causes at least partial conversion of the resin to the thermoset state..

- In the second preferred process the decorative paper is associated in superimposed relationship
- 70 with one or a plurality of non-decorative rapid-curing noble resin, more especially, rapid curing melamine-formaldehyde resin, impregnated paper sheets suitably, impregnated high quality alpha-cellulose overlay sheets, then the superimposed
- 75 sheets are embossed with the application of heat so as to cause at least part of the resin from the non-decorative sheet(s) to impregnate the decorative sheet, the associated sheets to become embossed and the thermosettable
- 80 resin(s) converted at least partially to the thermoset state.

The embossed decorative sheets may be prepared by embossing sheets of the required size using suitably contoured matched metal plates, or

85 more preferably, they may be prepared by embossing a continuous web of the decorative paper by roll-embossing techniques and then cutting said web into sheets of the desired size. Suitably, the decorative papers are those known for use in the production of conventional

90 decorative laminates and have a basis weight of about 80 to about 220 g.s.m.

In preferred processes it is desirable that the embossing process, the heat applied and the rate of cure of the thermosettable melamine resin be such that in conjunction they provide pre-

95 embossed noble resin impregnated decorative paper sheets at an economic rate.

- The resin content of the paper, the depth of
- 100 embossment and the extent of conversion of the resin to the thermoset state must be such as to cause the embossed sheet substantially to resist deformation by the consolidation pressure applied thereto when positioned in the assembly
- 105 comprising the other components of the laminate and the deformable press-pad. Preferably, determination of the optimal resin content, the temperature to be applied, the required extent of cure of the resin and the embossing rate is by
- 110 prior experimentation. When the decorative sheet is not previously resin impregnated and the embossing is performed on the decorative sheet in association with a resin impregnated sheet(s) then the resin flowability and content of the
- 115 associated sheet or sheets must be such as to allow sufficient resin to impregnate the decorative sheet to ensure adequate bond strength between it and the other laminate components and also such as to provide sufficient rigidity in the
- 120 embossed composite that it resists the consolidation pressure applied during the laminating operation.

However, irrespective of the manner of embossment of the decorative paper sheet, it is

125 preferred that the resin content of the pre-embossed decorative paper sheet together with the resin content of the wear surface layer, when present, should be such as to provide a noble thermoset resin content in the surface layer(s) of

the decorative laminate of from about 20% to about 60% and, more preferably, from about 30% to about 50% by weight.

- The depth of embossment that may be imparted to the decorative paper sheet is, of course, limited by the properties of the paper; too great a depth causes unacceptable rupture of the sheet. Further, the depth of embossment obtainable is dependent upon the method used for the embossing operation. When sheets are embossed statically between metal plates the depth of embossment that may be achieved is usually greater than that achievable by a roll embossing process because of the physical and mechanical problems of causing the sheet or web to be deformed rapidly during the limited duration of its association with the rollers. Whilst the depth of embossment may be as much as 0.5 mm or greater, it is preferred to limit the embossment depth to about 0.3 mm as such may be easily and economically achieved by both plate- and roll-embossing processes whilst providing decorative laminates having a marked degree of embossment together with satisfactory durability.
- The wear surface layer comprising a noble thermoset resin may be provided in any suitable manner. As related above, it may be provided as a thermosettable resin impregnated overlay sheet such as is employed for the production of conventional decorative laminates or it may comprise an embossed noble resin impregnated paper overlay sheet which conforms to—and which has been embossed in association with—the decorative paper sheet and which together with the embossed decorative sheet is positioned as a composite in the laminate stack. Suitably the overlay sheet is one known for use in conventional laminates and has a basis weight of from about 20 to about 50 g.s.m.
- Further, the wear surface layer may be provided as a coating, comprising a thermosettable resin and a finely divided filler on the decorative surface of the decorative sheet prior to its embossment. Suitably the filler is a mineral filler such as, for example, alumina, silica or barium sulphate, or an organic filler such as fibrous or microcrystalline cellulose. When such a coating is employed it must be such that it is at least partially thermoset and caused to conform to the decorative layer during the embossing process.

The deformable press-pad used in the process of the present invention is comprised either of an elastomeric or thermoplastic material.

- The press-pad is such as to be at least co-extensive with the laminate stack. If an elastomeric press-pad is used, then the thickness should be such as to be at least as great as and, preferably, about twice as great as the depth of embossment of the decorative paper. The elastomer may be of any suitable hardness provided that, substantially, it conforms to, and preserves the contours of, the pre-embossed decorative sheet during consolidation of the stack. The preferred hardness is preferably

determined by prior experimentation with a pre-embossed sheet having the form and depth of embossment desired in the product laminate.

- If a thermoplastic press-pad is used, this must be such that during the heat and pressure consolidation it becomes fluid and so conforms readily to the contours of the pre-embossed decorative paper sheet but not so fluid as to be substantially expressed from the assembly during the consolidation. Clearly the press-pad must be such that in the fluid state there is at least sufficient volume to fill the depressions in the embossed decorative sheet. When preparing laminates according to the invention and comprising melamine-formaldehyde resins the preferred thermoplastic press-pad comprises polyethylene, more especially, as such is commercially available in a variety of thicknesses and at economically attractive prices.
- Surprisingly when utilising a deformable thermoplastic press-pad it is not essential that the press-pad be heated to about its flow point before the consolidation pressure is applied. The preparation of the stack and assembly and the pressing may be accomplished according to the process of the invention essentially similarly to those operations used to produce conventional laminates.

- A preferred mode of operation is to position a conventional release sheet between the decorative layer or wear surface layer, when present, and the deformable press-pad and between adjacent stacks if a plurality of stacks are consolidated simultaneously. The release sheet may be any of those known for use in the production of conventional plastics laminates such as polypropylene or aluminium foil-faced paper sheets and by suitable selection of the release sheet a desired texture may be provided on the wear surface of the product laminate as is wellknown. The following Examples are given so that the instant invention may be more clearly understood. All parts and percentages are by weight unless otherwise specified.

#### 110 Example 1

- A 120 g.s.m. opaque white pigmented alpha-cellulose decorative paper sheet is impregnated with a thermosettable melamine-formaldehyde resin composition having an M:F ratio of 1:1.8 and containing 0.5% by weight of an acid catalyst on the resin solids. After drying, the resin content of the impregnated decorative paper is about 56%.

- The impregnated sheet is then positioned between an aluminium foil and a polypropylene release sheet and then embossed between two steel plates, one being a flat plate and the other bearing an etched grid pattern about 0.05 mm deep, by subjecting the assembly to a pressure of 100 Kg/cm<sup>2</sup> for 1 minute at a temperature of 120°C. After removal from the press and stripping away the release sheet and aluminium foil, the embossed partially thermoset melamine resin-impregnated decorative sheet so provided is

positioned in a stack upon a release sheet, the stack comprising:—

- (a) 6 sheets of conventional thermosettable phenolic resin impregnated kraft paper; and
- (b) the embossed decorative sheet with that surface that had been adjacent the flat steel plate adjacent the core sheets;

The assembly is then completed by positioning upon the decorative sheets:—

- (i) a polypropylene release sheet;
- (ii) a deformable press-pad comprising two sheets of polyethylene film each 50 microns thick and co-extensive with the stack; and
- (iii) a further polypropylene release sheet.

- The assembly is then consolidated to a unitary thermoset laminate by heating under pressure in a conventional hydraulic laminating press. The pressure applied being about 100 Kg/cm<sup>2</sup> and the temperature about 140°C.

- After cooling the assembly and removing it from the press the various release sheets and the polyethylene press-pad are stripped off to provide a white decorative laminate having an embossed surface which exhibits a raised grid structure about 0.05 mm high.

#### Example 2

- A 130 g.s.m. opaque white alpha-cellulose decorative paper sheet is impregnated with an acid catalysed thermosettable melamine-formaldehyde resin having an M:F ratio of 1:2.3 to a resin content, after drying, of about 56%.

- A 213 g.s.m. kraft paper core sheet is impregnated with a conventional thermosettable phenolic resin composition to provide a resin content of about 30% after drying.

- The sheets are superimposed and embossed as in Example 1 but with the assembly subjected to a pressure of 100 Kg/cm<sup>2</sup> at 120°C for 10 minutes and with the decorative sheet adjacent the etched metal plate, to provide a composite having an embossed partially thermoset melamine resin impregnated decorative layer and a partially thermoset phenolic resin support layer.

- The composite is then used to prepare a laminate as in Example 1 by positioning it in a stack in place of the embossed decorative sheet of Example 1.

- Again the product laminate is a white decorative laminate exhibiting a raised grid structure on its decorative surface.

#### Example 3

- A 40 g.s.m. high-quality unpigmented alpha-cellulose overlay paper sheet is impregnated with a thermosettable melamine resin having an M:F ratio of 1:2.3 to provide a resin content of about 68%.

- A 125 g.s.m. high-quality decorative paper sheet printed with a wood grain pattern with the grain lines darker than the other areas is impregnated with a thermosettable melamine resin composition having an M:F ratio of 1:1.5 to provide a resin content, after drying, of about 26%.

- An unbleached kraft paper sheet having a basis weight of 80 g.s.m. is impregnated with a melamine-formaldehyde resin having an M:F ratio of 1:2.3 to provide a barrier sheet having a resin content after drying of 30%.

- The sheets are superimposed and embossed as in Example 2 using an embossing plate provided with embossments corresponding in shape, size and position to the grain lines on the decorative sheet and the latter and the overlying overlay are so positioned that the grain lines and embossments coincide.

- The composite thus produced and comprising an embossed melamine resin impregnated barrier sheet, a pre-embossed melamine resin impregnated printed decorative sheet and a melamine resin impregnated embossed overlay paper sheet, wherein the melamine resins are partially cured to the thermoset state, is used to form a laminate as related in Example 1 except that the composite (with the overlay sheet distant from the phenolic resin impregnated kraft papers) is inserted in the stack in place of the embossed white decorative sheet.

- The product laminate is a registered embossed thermoset decorative laminate wherein the areas corresponding to the depressed grain lines are darker in colour than the surrounding areas and the laminate closely approximated in appearance a natural wood grain panel.

#### Example 4

- A web of 120 g.s.m. high-quality wood grain printed decorative paper is impregnated with a plasticised melamine-formaldehyde resin having an M:F ratio of 1:1.8, and containing 0.5% by weight of an acid catalyst on the resin solids, to a resin content of 37% after drying.

- The impregnated paper is then embossed and the melamine resin partially cured by a roll-embossing technique wherein the paper web is passed through the nip formed between (i) a metal embossing roll engraved to provide protuberances 0.1 high and of the same dimensions and spacings as the grain lines on the printed sheet and (ii) a rubber covered backing roll. The embossing is carried out with a line loading of about 36 Kg/cm at the nip and a paper feed rate of about 4 metres per minute. The metal embossing roll is internally heated so as to provide a surface temperature of about 145°C and the web and embossing roller are so aligned that the protuberances on the embossing cylinder corresponded with the grain lines on the printed web. The temperature and rate of embossing are such as partially to convert the resin to the thermoset state. The web is then cut into sheets of the required size, each sheet being a pre-embossed melamine resin-impregnated printed decorative sheet wherein the grain lines are in register with the embossments.

- A 40 g.s.m. high-quality alpha-cellulose paper overlay sheet is impregnated with a conventional thermosettable melamine resin to a resin content of about 65% and a decorative laminate is

prepared from the pre-embossed decorative paper sheet and the overlay sheet as related in Example 1 except that the printed embossed sheet and the overlay are inserted in the stack in place of the plain coloured embossed sheet of that Example.

The product laminate is a registered embossed decorative laminate having a depth of embossment of about 0.1 mm and grain lines in register with the embossed areas and the laminate closely approximates in appearance a natural wood grain panel.

#### Example 5

A web of 125 g.s.m. high-quality decorative paper printed in a tile panel pattern, with the orange brown areas representing the tiles defined by surrounding white areas representing grout lines is impregnated, as in Example 4, to a resin content of about 37% after drying. A web of 40 g.s.m. unpigmented high-quality alpha-cellulose overlay paper is impregnated to a resin content of about 54% with a melamine formaldehyde resin composition having an M:F ratio of about 1:2.2 and comprising 0.5% by weight of the resin solids of an acid curing catalyst.

The webs are superimposed and embossed with a grout line pattern in register with the printed grout line by passage through the nip formed by (i) an internally heated metal roller bearing in relief the grout line pattern and (ii) a rubber covered backing roller. The relief pattern is about 0.3 mm high and the rate of passage through the nip of the super-imposed webs (with the overlay web adjacent the metal roller) is about 2.5 metres per minute. The metal roller is internally heated to provide a surface temperature of about 142°C.

The material emergent from the nip is in the form of a two layered composite web, the bottom (decorative) layer of which comprises a printed registered pre-embossed partially thermoset melamine resin impregnated decorative paper web and the top layer (wear surface) comprises an embossed partially thermoset melamine resin impregnated overlay web the surface of which conformed to the embossed grid pattern of the decorative sheet.

A decorative laminate is then prepared as follows:—

Upon a polypropylene release sheet a stack is formed comprising:

(a) 5 sheets of thermosettable phenolic resin impregnated kraft paper sheets.

(b) a sheet cut from the composite was prepared as related above and comprising (i) the embossed printed partially thermoset melamine resin impregnated decorative paper sheet and (ii) the embossed partially thermoset melamine resin impregnated overlay sheet.

A press assembly is then formed by positioning upon said stack a polypropylene release sheet (adjacent the overlay) and a 2.5 mm thick sheet of silicone rubber having a durometer hardness of about 60.

The assembly is then consolidated at a temperature of about 140°C and a pressure of 100 Kg/cm<sup>2</sup> for about 20 minutes. After cooling and removing the assembly from the press the deformable silicone rubber press pad is removed and the release sheets stripped off to provide a decorative registered embossed laminate closely corresponding to a panel of orange brown tiles separated by white grout lines each about 0.3 mm deep.

#### Example 6

A web of 125 g.s.m. high-quality decorative paper printed with a wood grain pattern is impregnated with a melamine resin as in Example 4 to provide a resin content of 30% after drying.

The web is then coated with a composition comprising (a) 50 parts of the same melamine resin as used to impregnate the decorative web dissolved in 50 parts of an alcohol/water solvent, and (b) 25 parts of finely divided barium sulphate. The coating is applied in two operations so as to provide on the decorative sheet, after drying to a volatile content of 5%, a coating weight of about 100 g.s.m.

The coated decorative web is then embossed and the melamine resins partially thermoset, as in Example 4, with the coated surface adjacent the metal roller and with a polypropylene release foil intermediate between the coated surface and the metal roller.

The embossed web emergent from the nip of the rollers is a composite of the coated embossed decorative paper web and the release foil which is temporarily adherent to, and followed the contours of, the embossed decorative paper web.

The composite is cut into sheets of the required size and a stack is built up as follows:—

(a) 5 sheets of thermosettable phenolic resin impregnated kraft paper core sheets; and  
(b) the embossed composite sheet prepared as above.

An assembly comprising (between polypropylene release sheets):—  
(i) the stack prepared as above, and  
(ii) two sheets of polyethylene each 50 microns thick and co-extensive with the stack, is then consolidated to a unitary thermoset decorative laminate exhibiting a registered embossed woodgrain effect by heating under pressure in a laminating press at a pressure of about 100 Kg/cm<sup>2</sup> and a temperature of 135°C for 25 minutes.

#### Example 7

A 130 g.s.m. opaque white pigmented high-quality decorative paper sheet is impregnated with an acid catalysed thermosettable melamine-formaldehyde resin having an M:F ratio of 1:2.3 to a resin content, after drying, of 56%.

A standard 213 g.s.m. kraft paper core sheet is impregnated with a conventional thermosettable phenolic resin composition to provide a resin content of about 30% after drying.

The sheets are superimposed and positioned

- between an aluminium/paper foil (with the aluminium surface adjacent the decorative sheet) and a polypropylene release sheet and pressed between metal plates at a pressure of 100 Kg/cm<sup>2</sup> for 1 minute at a temperature of 120°C. The press-plate associated with the decorative sheet has an engraved stipple pattern ranging in depth up to 0.5 mm whilst the plate associated with the kraft sheet is flat.
- 10 The composite sheet thus produced has an embossed surface complementary to that of the engraved metal plate and a flat back and comprises a partially thermoset melamine-formaldehyde resin impregnated decorative sheet and a partially thermoset phenolic impregnated support sheet.
- The composite is then employed to prepare an embossed decorative laminate as in Example 1 by positioning it in a stack in place of the embossed decorative sheet of that Example.

20 The laminate thus produced exhibits a stippled surface complementary to that of the engraved plate wherein the height of the embossments (stipples) ranged up to 0.5 mm.

#### 25 Example 8

- (i) a web of 80 g.s.m. high-quality unimpregnated decorative paper printed with a two-colour geometric design;
- (ii) a web of 40 g.s.m. alpha-cellulose overlay paper impregnated to a resin content of about 68% with a thermosettable melamine-formaldehyde resin composition having an M:F ratio of about 1:2.3 and comprising 0.5% by weight of the resin solids of an acid curing catalyst, and
- (iii) a web of aluminium release foil, are arranged, in the order stated in superimposed relationship and embossed with a geometric design in register with the printed geometric design by passage through a heated embossing nip as in Example 5. The aluminium foil being adjacent to the heated metal roll.

The resin composition in the overlay and the embossing conditions being such as to cause the decorative paper to become embossed and impregnated with part of the melamine resin from the impregnated overlay and the resin to become partially thermoset.

A registered embossed decorative laminate is then prepared as follows:—

- Upon a siliconised release sheet a stack is formed comprising:—
- (i) 3 conventional thermosettable phenolic resin impregnated kraft paper core sheets;
- 55 (ii) a thermosettable melamine-formaldehyde resin impregnated kraft paper sheet;
- (iii) a sheet cut from the composite web prepared as related above and comprising:—
- (a) the embossed aluminium release foil;
- 60 (b) an embossed partially thermoset melamine-formaldehyde resin impregnated overlay sheet; and
- (c) an embossed partially thermoset melamine-formaldehyde resin impregnated printed

- 65 decorative sheet with the embossments in register with the printed design, with said decorative sheet adjacent the core sheets;
- (iv) two sheets of polyethylene, each 60 microns thick, and
- 70 (v) a further siliconised release sheet.
- The stack is then consolidated by heating to a temperature of about 140°C at a pressure of about 105 Kg/cm<sup>2</sup> for about 20 minutes between the platens of an hydraulic press.
- 75 After cooling and removing the stack from the press, the release sheets, polyethylene layer and aluminium foil layer are stripped away to provide a thermoset decorative plastics laminate having an embossed surface in register with a printed design on the decorative sheet. The depth of embossment of the laminate is about 0.2 mm and closely corresponds to the depth of engraving of the metal roll.

#### Example 9

- 85 A web of 130 g.s.m. opaque white pigmented high-quality decorative paper is printed in a green ink to provide a repeating design of a green disc surrounded by a green frame. The unimpregnated printed web is then positioned between webs of 90 40 g.s.m. unfilled high-quality alpha-cellulose paper overlay, each web being impregnated to a resin content of about 68% with a thermosettable melamine-formaldehyde resin composition having an M:F ratio of about 1:2.3 and comprising 0.5% by weight of the resin solids of an acid curing catalyst.

The plurality of webs are sandwiched between an aluminium/paper texturing web, adjacent the printed surface of the decorative web, and an aluminium release foil and the sandwich thus formed embossed by a roll-embossing technique as in Example 5. However, in the present Example the heated metal roller is provided with a relief pattern about 0.3 mm high consisting of (i) a square grid the dimensions of which are such as to correspond to the spacings between the green frames on the printed paper and (ii) circular prominences corresponding in size and spacing to the green discs on the printed paper.

110 The resin composition in the overlay webs and the embossing conditions being such as to cause the decorative web to become embossed and impregnated with part of the resin from the overlays.

115 A sheet is cut from the composite sandwich web and the aluminium release foil stripped off. A registered embossed decorative laminate is then prepared as follows:—

- A stack is formed comprising in order:—
- 120 (i) a conventional siliconised release sheet;
- (ii) 5 sheets of conventional thermosettable phenolic resin impregnated kraft paper core sheets;
- (iii) the sheet cut from the web prepared as above with the exposed overlay sheet adjacent the uppermost core sheet;
- 125 (iv) a deformable press-pad being two



superimposed polyethylene sheets each 60 microns thick; and

(v) a further siliconised release sheet.

- The stack is then consolidated as in Example 8 and the release sheets, the aluminium/paper texturing web and the polyethylene are stripped off to leave a registered embossed decorative thermoset plastics laminate exhibiting a repeating pattern of a debossed green disc surrounded by an embossed white area surrounded by a green frame and, external to the frame, a white debossed square grid pattern with the depth of embossment being about 0.3 mm.

#### Example 10

- A web of 130 g.s.m. opaque high-quality decorative paper printed with a brick panel pattern is positioned intermediate (i) a conventional overlay web impregnated with a thermosettable melamine-formaldehyde resin to a resin content of about 68% and (ii) a web of conventional kraft paper impregnated with a thermosettable melamine-formaldehyde resin to a resin content of 28%; the overlay web being adjacent to the printed surface of the decorative web.

- The superimposed plurality of webs is then sandwiched between siliconised paper webs and embossed, as in Example 9, so as to cause the decorative sheet to become impregnated with part at least of the resin composition from the impregnated overlay and kraft layers and the resins to become partially thermoset. The embossing being carried out with the use of an engraved metal roll bearing a relief pattern corresponding to that of the pointing between the bricks and having a depth of 0.1 mm.

- A decorative laminate is prepared therefrom as related in Example 9 and the laminate so produced exhibits the appearance of a brick panel with the pointing between the bricks being about 0.1 mm below the embossed areas corresponding to the bricks.

#### Claims

1. A process for preparing an embossed thermoset decorative laminate comprising:—

A: forming a stack comprising:—

- (i) a core layer, comprising one, or a plurality of, thermosettable phenolic resin impregnated paper sheets;
- (ii) a decorative layer comprising a pre-embossed noble resin impregnated decorative paper sheet; and optionally,
- (iii) *either* a wear surface layer conforming in contours to the pre-embossed noble resin impregnated decorative paper sheet and comprising a noble resin composition which is at least partially thermoset;
- or* a wear surface layer comprising an overlay impregnated with a noble thermosettable resin composition;

B: forming an assembly comprising:—

- (i) said stack, and
- (ii) a deformable thermoplastic or elastomeric press-pad adjacent said decorative sheet or wear surface layer;

C: applying heat and pressure to the assembly so as to cause the said press-pad to conform to said pre-embossed paper sheet and to consolidate the stack to form a unitary structure and to convert the thermosettable resins to the thermoset state;

D: removing said deformable pad to provide an embossed thermoset decorative laminate, the contours of the decorative surface of which conform substantially to those of the pre-embossed noble resin impregnated decorative paper sheet.

2. A process for preparing a registered embossed thermoset decorative laminate comprising:—

A: forming a stack comprising:—

- (i) a core layer which comprises one, or a plurality of, thermosettable phenolic resin impregnated paper sheets;
- (ii) a decorative layer which comprises a pre-embossed noble resin impregnated decorative paper sheet bearing a printed pattern, wherein the embossments are in register with the printed pattern; and
- (iii) *either* a wear surface layer conforming in contours to the pre-embossed noble resin impregnated decorative paper sheet and comprising a noble resin composition which is at least partially thermoset.

*or* a wear surface layer comprising an overlay impregnated with a noble thermosettable resin composition;

B: forming an assembly comprising:—

- (i) said stack, and
- (ii) a deformable thermoplastic or elastomeric press-pad adjacent said wear surface layer;

C: applying heat and pressure to the assembly so as to cause the press-pad to conform to said embossed paper sheet and to consolidate the stack to form a unitary structure and to convert the thermosettable resins to the thermoset state;

D: removing said deformable pad to provide a registered embossed decorative laminate the contours of the decorative surface of which conform substantially to those of the pre-embossed noble resin impregnated decorative paper sheet.

3. The process as claimed in Claim 1 or Claim 2 characterised in that the wear surface layer is provided as a coating, comprising a noble resin composition and a finely divided filler, said resin composition being at least partially in the thermoset state, on the decorative surface of the pre-embossed noble resin impregnated decorative paper sheet prior to the positioning in the stack, said layer conforming in contours to said sheet.

4. The process as claimed in Claim 1 or Claim

2 characterised in that the wear surface layer is provided as a noble thermosettable resin impregnated overlay sheet positioned on the decorative surface of the preembossed noble resin impregnated decorative paper sheet.

5 5. The process as claimed in any preceding claims characterised in that the pre-embossed noble resin impregnated decorative paper sheet is provided by first impregnating a decorative paper sheet with a noble resin composition and then simultaneously embossing the paper and at least partially converting the resin composition to the thermoset state by the application of heat and pressure.

15 6. The process as claimed in any preceding claim characterised in that the noble resin composition comprises a melamine-formaldehyde resin composition.

20 7. The process as claimed in Claim 6 characterised in that the melamine-formaldehyde resin is a rapid curing composition comprising an acid or latent acid catalyst.

25 8. The process as claimed in any one of Claims 1 to 4 characterised in that the pre-embossed noble resin impregnated decorative paper sheet is provided by associating in superimposed relationship a non-impregnated decorative paper sheet and one, or a plurality of, non-decorative rapid curing thermosettable melamine-formaldehyde impregnated paper sheets and applying heat and pressure to the superimposed sheets so as substantially simultaneously to cause them to become embossed, the decorative sheet to become impregnated with some at least of the resin of the non-decorative sheet(s) and the resin composition to become at least partially thermoset.

35 9. The process as claimed in any preceding claim characterised in that the pre-embossed noble resin impregnated decorative sheet is provided by roll-embossing means.

40 10. The process as claimed in any preceding

claim characterised in that the noble resin content of the decorative sheet and the wear surface layer, when present, is from about 20% to about 60% by weight.

45 11. The process as claimed in any preceding claim characterised in that the deformable press-pad comprises polyethylene.

50 12. A decorative embossed thermoset laminate comprising:—

(i) a core layer, being one, or a plurality of, thermoset phenolic resin impregnated paper sheets;

55 (ii) a decorative layer, being a pre-embossed noble resin impregnated decorative paper sheet, said resin being substantially fully cured to the thermoset state; and, optionally,

60 (iii) a wear surface layer comprising a noble thermoset resin composition which layer conforms to the contours of said pre-embossed decorative paper sheet.

13. A decorative registered embossed thermoset laminate comprising:—

65 (i) a core layer, being one or plurality of, thermoset phenolic resin impregnated paper sheets;

70 (ii) a decorative layer, being a pre-embossed noble resin impregnated decorative paper sheet bearing a printed pattern and wherein the embossments are in register with the printed pattern and the resin is substantially fully cured to the thermoset state; and

(iii) a wear surface layer, comprising a noble thermoset resin composition which layer conforms to the contours of said pre-embossed noble resin impregnated decorative paper sheet.

75 14. The decorative embossed thermoset laminate when prepared in accordance with any one of Claims 1 to 11.

80 15. The decorative embossed thermoset laminate when prepared substantially in accordance with any one of the Examples.

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G4H HU H13D

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(54) Abstract Title

Implementing logic circuits

(57) A programmable monolithic Integrated logic circuit includes look up table circuits and programmable logic array-like circuits. The integrated circuit can include a first number of the look up tables and a second number of the programmable logic array-like circuits and where the first and second numbers are related by a ratio of between 0.25:1 and 6:1, between 1:1 and 5:1, or about 4:1. The programmable logic array-like circuits can each include at least 10,000 or 50,000 equivalent two-input NAND gates and the look up tables and the programmable logic array-like circuits can each comprise static random access cells. A method of implementing a logic circuit includes reading a netlist that includes a plurality of subnets, determining the suitability of ones of the subnets to being implemented with look up tables and with programmable logic array-like circuits, and determining whether to implement each subnet with a look up table or a programmable logic array-like circuit based on results of the step of determining. Based on the steps of determining, the method implements a first subnet of the plurality of subnets with look up table circuits and a second subset of the plurality of subnets with programmable logic array-like circuits.

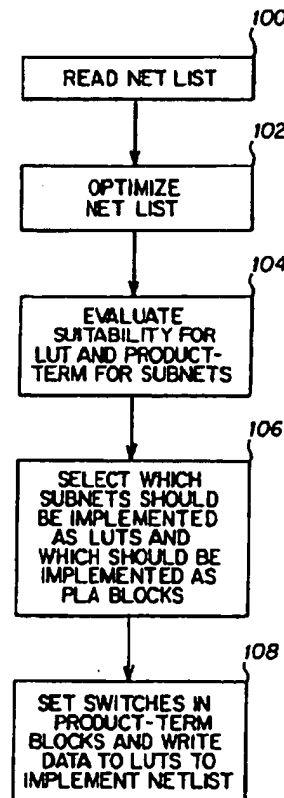
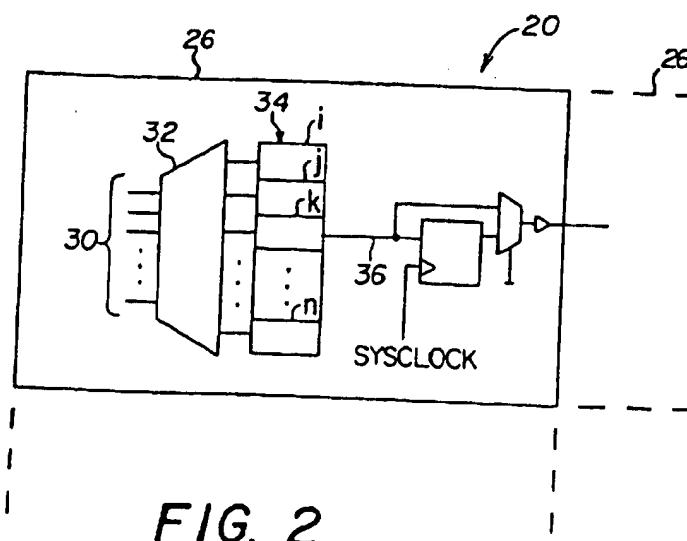
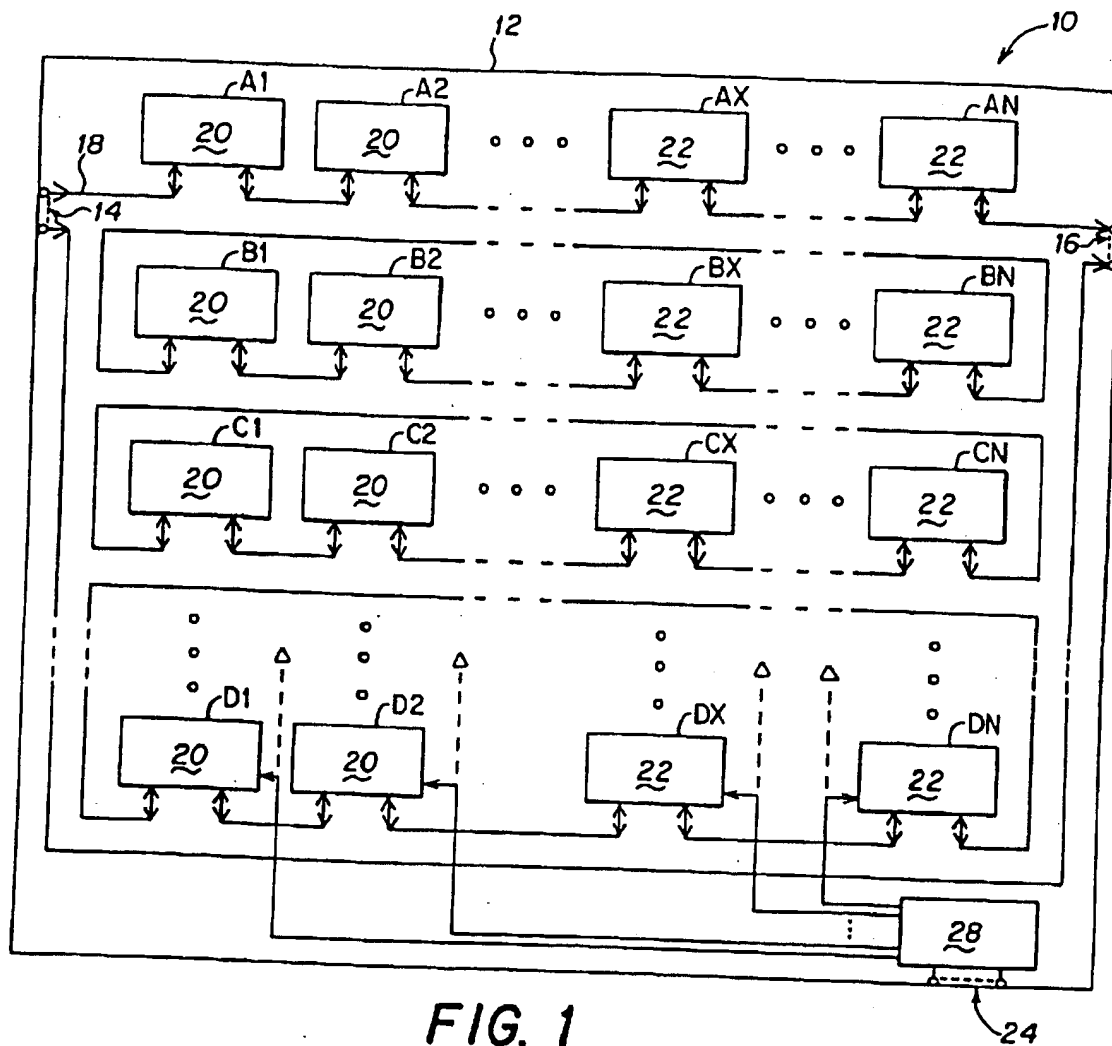


FIG. 6

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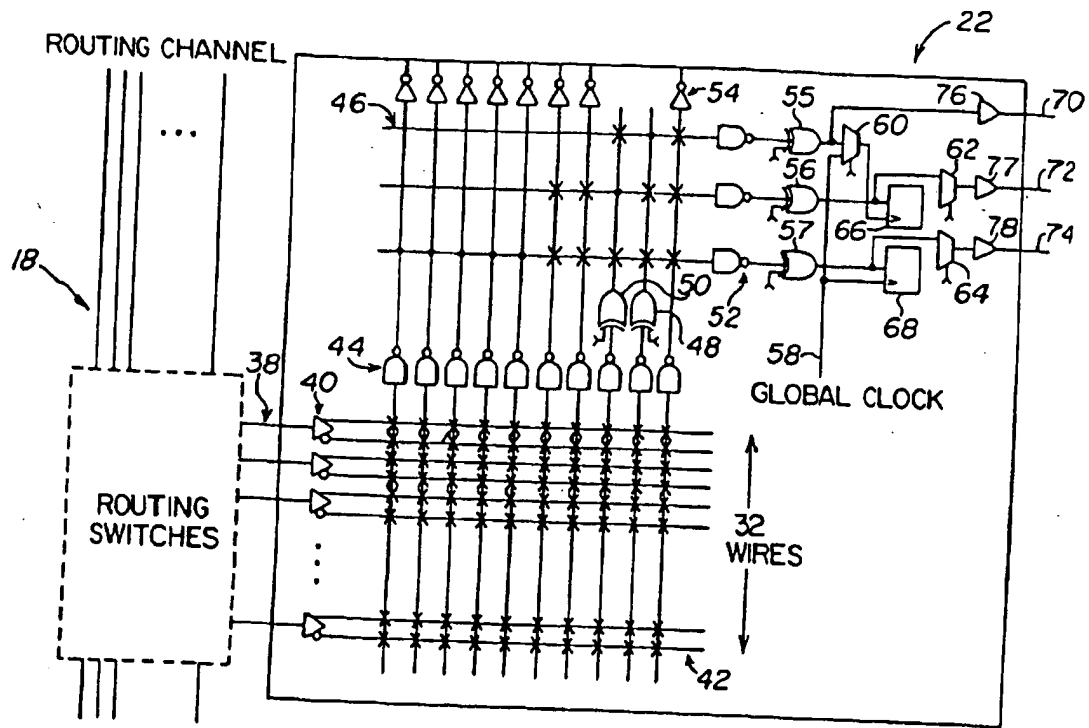


FIG. 3

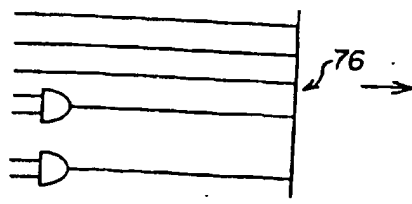


FIG. 4A

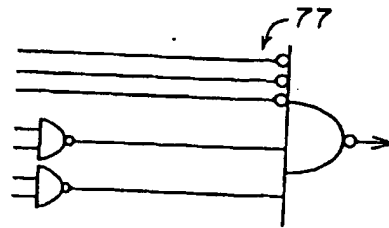


FIG. 4B

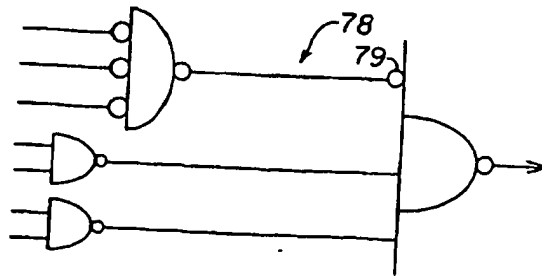


FIG. 4C

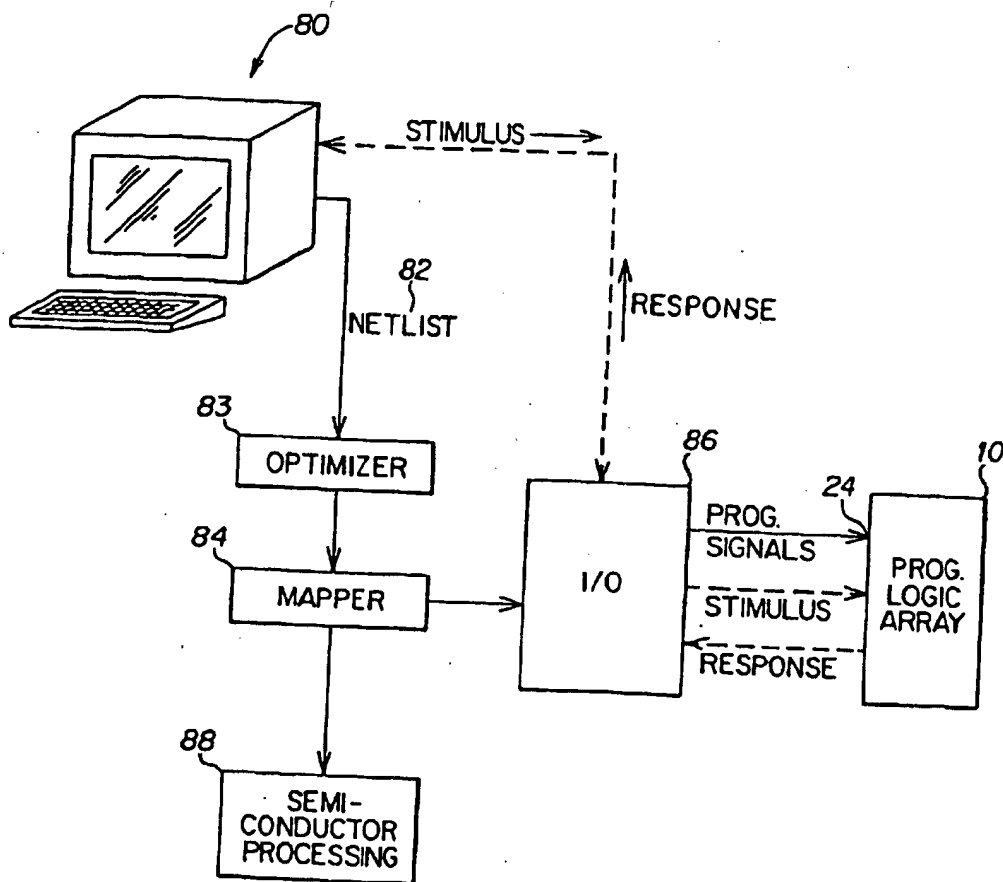


FIG. 5

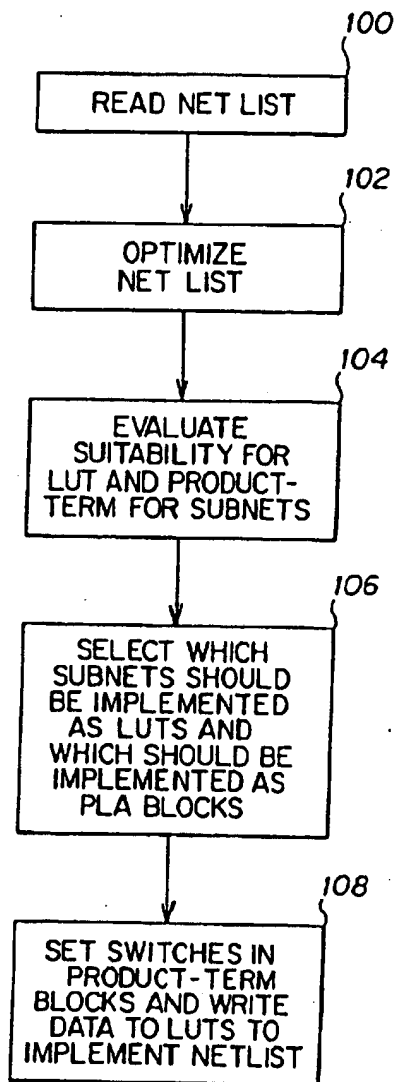


FIG. 6

S<sub>1/2</sub>

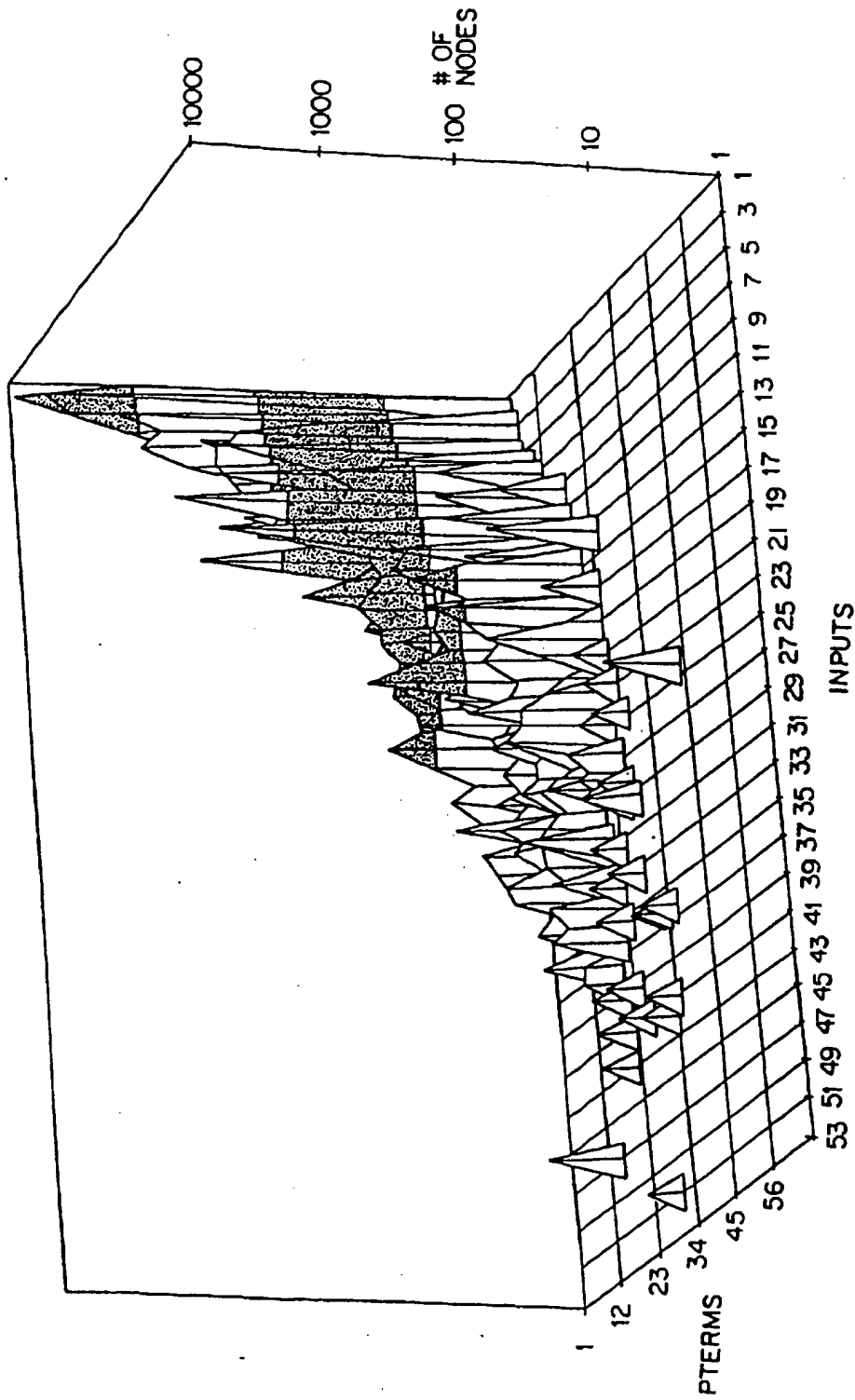


FIG. 7



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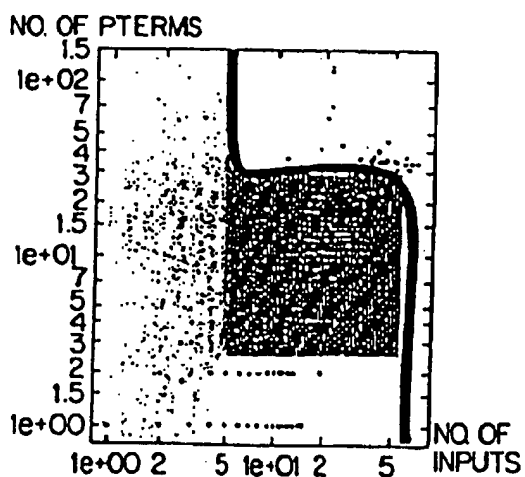


FIG. 8

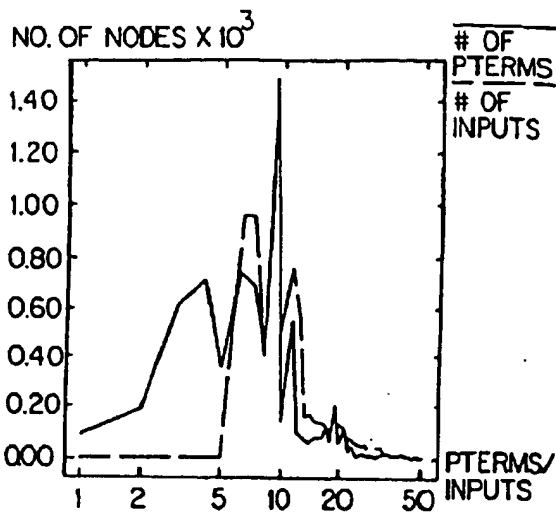


FIG. 9

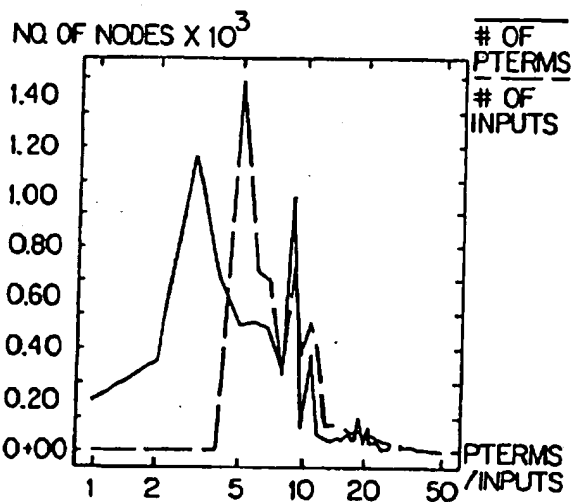


FIG. 10

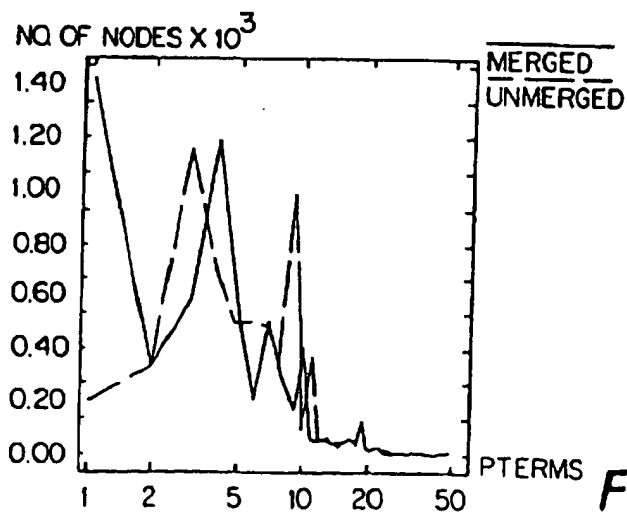


FIG. 11